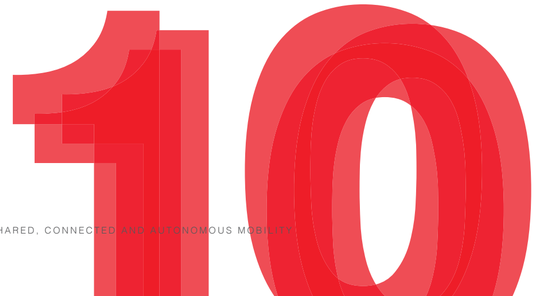
ARUP

10 thoughts for the future of shared, connected and autonomous mobility

Connected, shared and autonomous mobility is rapidly evolving, but the final end state is still unknown. These technologies present both major risks, such as increased congestion but also opportunities, such as more efficient transport systems. Proactive regulation, robust policy decision-making and strong public/private collaboration will provide the best path forward, whether new mobility technologies become fully adopted or not.

The COVID-19 pandemic has put further focus on how we move around our towns and cities. Connected, shared and autonomous vehicles will play a key role in a safe, sustainable and efficient future transport system.



Contents

Purpose of this document

This document forms part of a series of 30 thoughts on the future of mobility. The thoughts represent a selection of potential challenges, opportunities and changes we believe will have tangible impact in our cities.

In developing these thoughts, we have consulted a range of Arup and external thought leaders, and considered the potential implications across next generation mobility pricing, low emission, shared, connected and autonomous mobility.

Some thoughts are specific to their area, while others transcend their assigned category into other areas. This document is intended to increase awareness, foster collaboration and develop discussion around the opportunities and challenges that our societies will face in the near, medium and potentially far future.

At a glance

10 THOUGHTS FOR THE FUTURE OF SHARED, CONNECTED AND AUTONOMOUS MOBILITY

AT A GLANCE: 10 THOUGHTS FOR THE FUTURE OF SHARED, CONNECTED AND AUTONOMOUS MOBILITY

01 FULL AUTOMATION? ONLY IN PART.

Rather than full autonomy, the roll out of vehicles in the foreseeable future will continue to develop a range of driver assisted systems with autonomy features, for use in specific circumstances.

02 PLUG THE TRANSIT GAPS

The positive outcomes associated with autonomy lie in integration with the mass transit network, playing a role in helping connect people with mass transit and providing access to people typically underserved by public transport.

03 DRIVING INCREASED CONGESTION?

Autonomous vehicles on their own will not solve congestion in cities. Ownership and occupancy patterns, and other policy variables within the control of city decision-makers will shape whether the rise of autonomous mobility will translate into more or less congested roads.

04 PROMOTE SAFER MULTI-OCCUPANCY MOBILITY OPTIONS

High occupancy rides provide a way out of congestion. However, in a post pandemic world, securing hygiene conditions and public acceptance will be a significant challenge. MaaS can help transport restart its journey.

05 INTRODUCE AN OPEN MOBILITY AS A SERVICE PLATFORM

Cities must seek ways to compel mobility providers to sign up to a service platform shaped towards achieving public objectives. Non-proprietary data standards and open platforms that allow cities to share street-level data will ensure mobility insights are serving positive social outcomes.

06 PLAN FOR ACCESSIBILITY BEFORE CONNECTIVITY

Trading longer car trips for active travel, micromobility, local living and neighbourhood self-sufficiency can revitalise high-streets without negatively impacting on the success of business districts.

07 INTRODUCE FLEXIBLE SPACES

Flexible transport infrastructure can create more capacity in the system and make it fit for purpose at different times of the day, for different people. This must be delivered through a combination of affordable physical and digital measures, of which connected vehicles are an essential component.

08 INTEROPERABILITY IS KEY

A connected vehicle environment is made up of different components, players, roles and layers of data streams. Interoperability supports the development of new mobility services and, with the right governance, it can promote safer and more efficient travel.

09 SAFETY AND TRUST IS A MUST

Connected vehicles can increase road safety but also come with a number of security risks, both physical and digital, especially when they are linked to roadside infrastructure and fixed and virtual sensors.

10 RE-THINK HOW LAND IS USED

Shared autonomous vehicles and their evolution towards ‘moving spaces’ will have lasting impact on the form and function of our cities, promising denser, more sustainable and productive environments, but also posing risks for sprawl.

Why now?

NEW MOBILITY TECHNOLOGIES PRESENT BOTH RISKS AND OPPORTUNITIES FOR CITIES

Not acting proactively in the field of shared, connected and autonomous mobility would risk urban futures similar to the car-centric developments that prevailed in the 20th century.

If left unchecked, the widespread adoption of shared, connected and autonomous mobility could:

- Exacerbate sprawl
- Increase congestion and pollution
- Discourage active travel and human-centred spaces
- Create private monopoly power over mobility
- Decrease equal access to jobs

If shaped proactively, with clear regulation designed to optimise positive societal outcomes, widespread adoption could:

- Decrease congestion and pollution
- Free space for enhanced public spaces and high streets
- Solve the transportation first mile/last mile problem
- Improve mobility for vulnerable groups
- Increase equal access to jobs

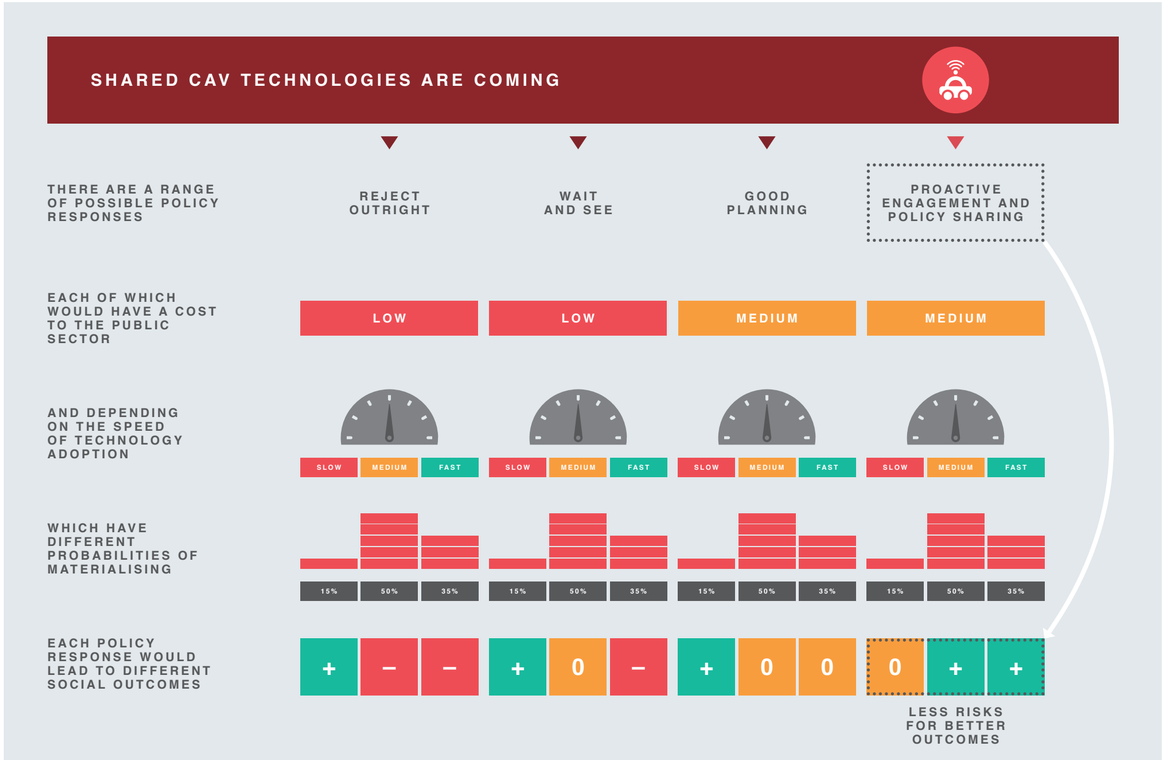
New mobility technologies will eventually transform cities and inter-urban movements. With every change there are winners and losers. We need to keep our eyes on the most important prize: making cities sustainable and liveable, while managing the supply and demand of transport in order to reduce pollution and congestion. We need to ensure that everyone has access to the opportunities afforded by transportation, and that cities are safe for walking, biking, and driving.

WHAT WE KNOW

Connected, shared and autonomous mobility is coming, but the end state is unknown and will be different in different places. These technologies present both risks and opportunities.

Potential responses are to:

- Reject the technologies outright
- Wait and see
- Continue to focus on good planning (land use, multi-modal, sustainable and human-centred designs)
- Regulate proactively



POTENTIAL OUTCOMES AND RESPONSES TO THE ARRIVAL OF SHARED, CONNECTED AND AUTONOMOUS MOBILITY

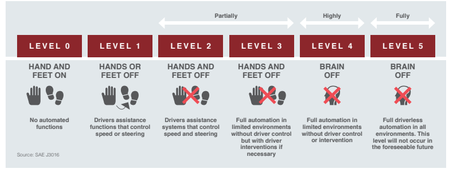
Decision tree of potential responses to Shared CAV technology deployment and their implications.

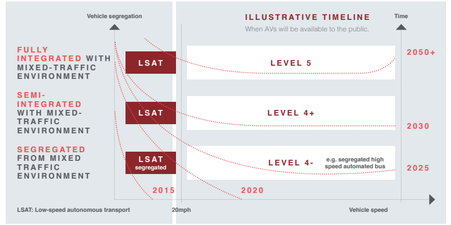
Defining autonomous mobility

Levels of automation increase from no automation (Level 0) to fully autonomous (Levels 4-5). A fully autonomous vehicle is driven by an AI system, rather than by a human driver. Level 4 vehicles will be referenced to specific geographies, such as neighbourhoods, highways or city boundaries whereas Level 5 vehicles will be able to drive anywhere. Deployment will be stepped, gradual, uneven and differentiated by context.

A self-driving vehicle does three things:

1. SENSE
2. PERCEIVE
3. DECIDE





Defining shared mobility

Shared mobility comprises any form of mobility in which the vehicle is not owned by an individual (i.e. fleet operated). Shared mobility solutions are shifting consumers' preferences away from car ownership toward newer forms of transportation.

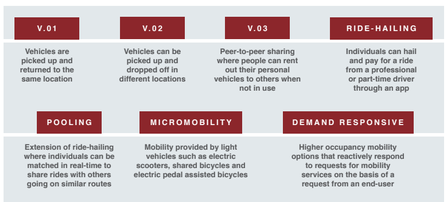
The market for shared mobility can be shaped in different ways, from the status-quo to more beneficial, transformative outcomes.

Business models for shared mobility providers may have to be re-imagined during and after COVID-19. Concerns about the safety of shared mobility options will be persistent, with pooling services likely to take the hardest hit. Sanitised ride-hailing and car-sharing services will however remain viable alternatives to private-car ownership and mass transit.

MOBILITY AS A SERVICE (MAAS)

Mobility as a Service (MaaS) brings every kind of transport together into a single intuitive mobile app. It seamlessly combines transport options from different providers, handling everything from travel planning to payments.

Payment systems in the context of MaaS refer to the integrated system for the lodging of a payment from the user to the end operator, ensuring continuity, security and validity of payment across all parties.

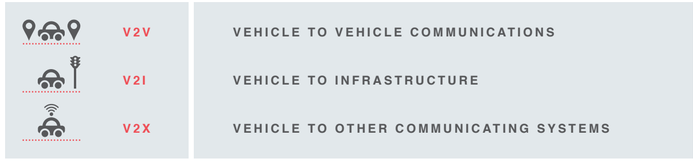


Defining connected mobility

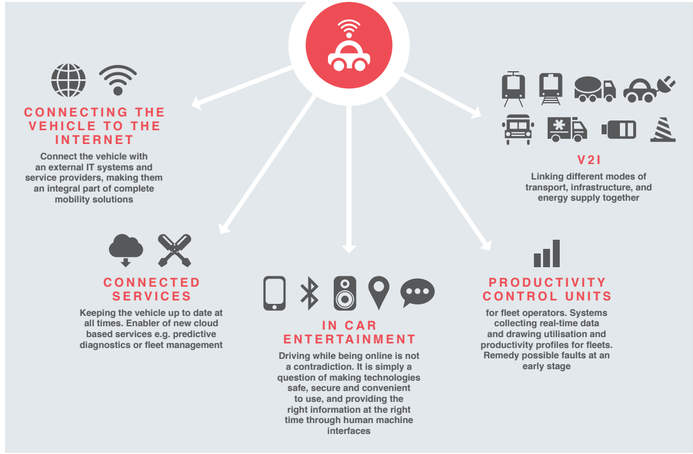
Connectivity opens up new opportunities to develop and improve vehicles and mobility services, which makes mobility safer, more efficient, and more convenient. It allows vehicles to communicate with each other and the world around them. The concept is about supplying useful information to a driver or a vehicle to help the driver make safer and more informed decisions.

Network Operators will have the ability to optimise the efficiency of the road network through increased access to data from vehicles and intelligent infrastructure. Connected vehicles will be in a position to share and receive information about their journey, including incident detection, weather alerts, road works etc. Through data it will be possible to identify where assets are going to fail in advance rather than reacting and increasing the overall operational efficiency of the road network.

All of these communications channels are vulnerable to cyber attacks. One mitigation is to close down the vehicle to outside communications (create an 'orphan vehicle'). The vehicle then needs to have enough computing power on board to process to do everything it needs, and other applications such as network-wide optimisation would no-longer be achievable.



EXAMPLES OF CONNECTED VEHICLE SERVICES



01 Full automation? Only in part.

Full autonomy of vehicles will not happen on our streets in the foreseeable future. Deployment of full autonomy will be staged, gradual and context-specific.

NO REGRETS DECISIONS

- Accelerate the deployment of trials and pilots in mixed vehicle environments
- Design trials to include transparent data-sharing
- Develop appraisal frameworks making the value-for-money case for enabling infrastructure
- Develop robust standards for operational control and safety
- Review the regulatory environment of contained sites, such as ports and airports
- Study how driver assisted systems will influence movement, safety and road design

LEVEL 5 AUTONOMY WILL NOT HAPPEN IN THE FORESEEABLE FUTURE

Level 4 vehicles require thousands to millions of miles of local testing and simulations before they can be implemented in a new environment.

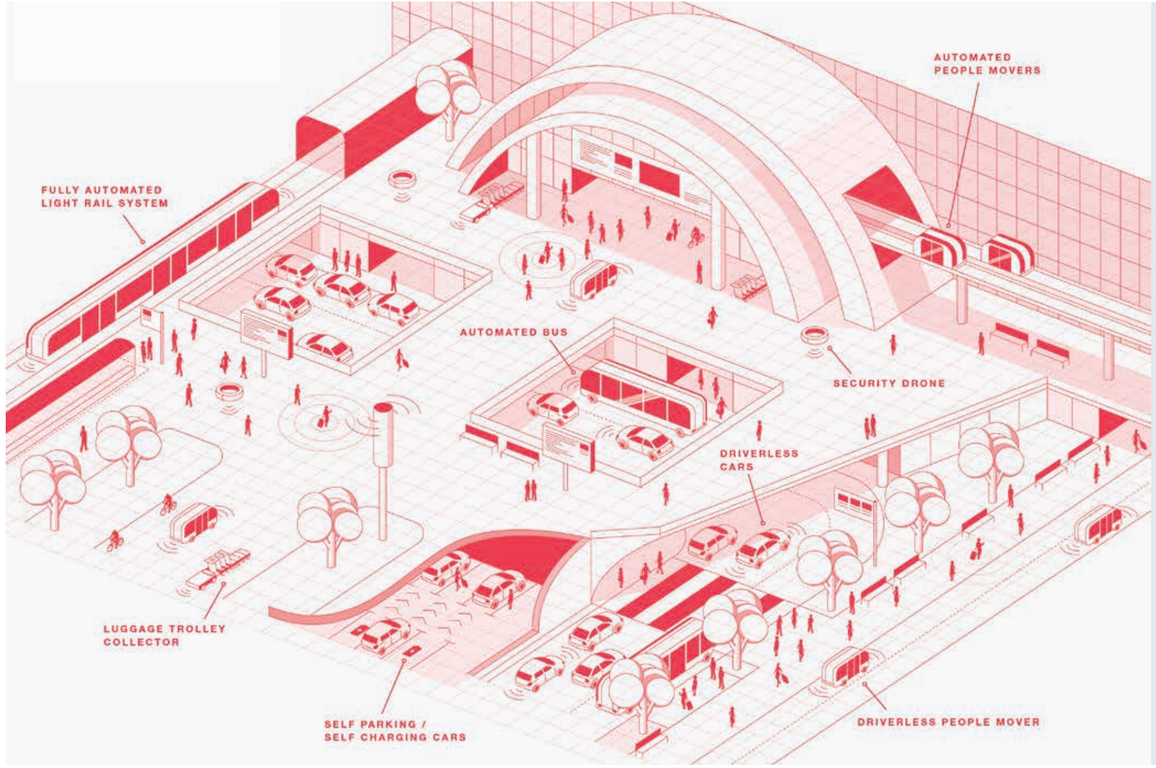
Level 4 vehicles are currently operating in some cities, airports, container ports and mines. Testing can help to identify crash prone locations and missing signage. It informs how infrastructure should be modified to best accommodate autonomous technologies.

DIGITAL VERSUS PHYSICAL INFRASTRUCTURE

Digital infrastructure is now as important as the physical. Understanding how the physical world is represented using data is crucial and we should consider how we can create innovation at the physical/digital intersection through devices such as Digital Twins and exploitation of digital data sets linked to signs and lines.

AIRPORTS AND PORTS MAKE GREAT TEST BEDS

Autonomous technologies have the capacity to operate and unlock efficiency savings within the terminal or yard and up to an aircraft/ship on the stand, thereby automating the whole process.



Case study

PORT OF HONG KONG AUTO TRUCKS

Arup was commissioned by Hong Kong International Terminals to create a traffic policy for external trucks and autonomous trucks which operate within a container port terminal. The proposed policy framework included traffic policies and guidelines for autonomous trucks, safety improvement measures for exceptional case handling, roadway design, intersection design and control signals.

02 Plug the transit gaps

Autonomous cars should not come at the expense of good public transport options. Autonomy can help to make public transport more affordable and attractive.

NO REGRETS DECISIONS

- Implement communication systems providing real time information on public transit crowding levels
- Integrate transit services with autonomous last mile solutions at ticket purchase
- Investigate the viability of business models feeding last mile communities to transit stations
- Review applicability of autonomous transit in high capacity corridors
- In a post pandemic world, some aspects of social distancing and travel behaviours should become habits e.g. more space for cycling and walking. Action should be taken to ensure others, such as the decline in mass transit, do not make their way into the 'new normal'

REALISING THE POTENTIAL OF MASS TRANSIT

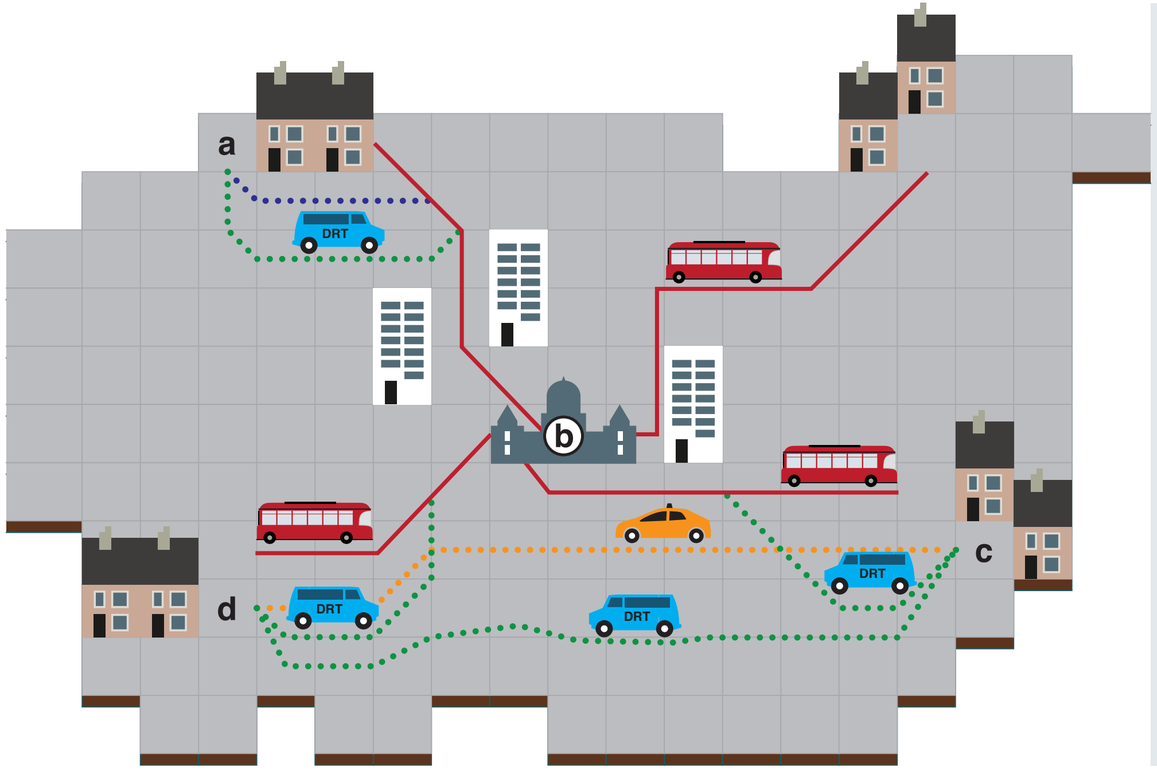
Autonomous Vehicles (AVs) can help to provide affordable solutions to fill transit gaps by solving the first and last mile problem. For example, connecting remote communities with efficient shared services may no longer require high levels of subsidies.

RE-THINKING PUBLIC TRANSIT

Combined with real-time data, mass transit can become more efficient and reliable, embracing flexible, demand responsive routing enabling them to move more people at less costs. Mass transit automation increases operational efficiency and safety while potentially generating cost savings.

RESPONDING TO COST PRESSURES ON OTHER PARTS OF THE NETWORKS

AVs will bring down the cost of car travel (even at level 2-3 partial automation e.g. by removing time costs in bumper to bumper traffic situations), creating price pressures on public transit.



Case study

INTEGRATED DEMAND RESPONSIVE TRANSPORT IN CITIES

Arup produced a report testing the feasibility of integrated demand responsive transport (DRT), using real data from medium-sized UK cities. In the scenarios considered, we replace poor performing low frequency buses with an integrated demand responsive transport service that shuttles users to a high frequency bus route.

From our preliminary study, integrated demand responsive transport appears to hold great potential. However, its future remains uncertain. The actions of bus companies, digital new entrants, taxi companies and local authorities will govern the path forward, and we challenge these groups with several provocations that we believe will spark a new revolution of demand responsive transport, enabling a more inclusive and effective public transport system.

03 Driving increased congestion?

Autonomous mobility is not the technical silver bullet solution to solving congestion.

NO REGRETS DECISIONS

- Consider prioritising AV development in places with the poorest accessibility to services and goods
- Incentivise higher occupancy rides
- Investigate fair, equitable and dynamic road pricing mechanisms
- Reserve additional capacity created by AVs to specific modes
- Consider land use approaches to congestion management

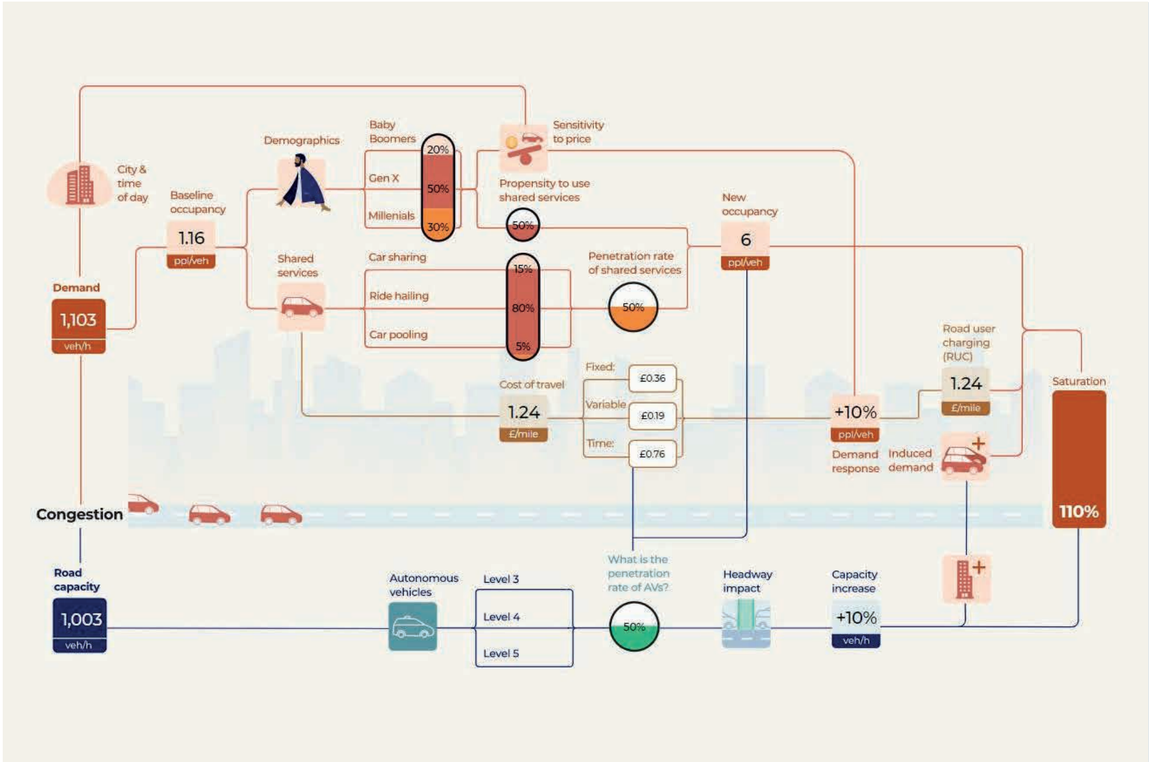
WHERE CAPACITY IS CREATED, INDUCED DEMAND WILL FILL IT

The way cities are built determines mobility needs and how they can be met. Development, urban design and public spaces, building and planning regulations, parking requirements, and other land use policies should incentivise compact, accessible, liveable, safe, hygienic and sustainable cities.

The increased convenience of car travel that AVs may generate, together with their potential of releasing up to 25% more capacity with 100% market penetration risks creating further urban sprawl. If more capacity is created, demand for car travel will catch up through mode shifts, route shifts and long-run land use changes that create new and longer trips.

VEHICLE OWNERSHIP PATTERNS AND OTHER POLICY VARIABLES WILL PLAY AN IMPORTANT ROLE

Whether that is through the cost of the vehicle itself, its insurance, fuel, parking, tolls, hail fares, or the cost of time spent travelling – different adoption rates of each new mobility technology will generate a new cost of travel for car drivers. AVs on their own will generate a positive demand response. Policies can influence the type and size of vehicle fleets, occupancy levels, the mix between transit and shared vehicles, the types of new developments, which can mitigate this demand response.



Case study

CONGESTION IMPACT TESTING TOOL

Arup has developed a digital tool to test the congestion impacts of different penetration rates for autonomous and shared mobility. Impact variables are shown below. In thinking through the potential implications of multiple future changes in a clear way, we can help city decision makers manage risk in the face of uncertainty, while also adding a measure of flexibility to policy decisions. With appropriate market shaping, autonomous vehicles and mobility services could help cure congestion in cities. Our visualisation can give decision makers a better understanding of how changes in different parameters within their control are likely to impact actual behaviour; hence it will help them to identify the most critical areas for new regulations and policies when trying to solve congestion problems.
www.avcongestion.com

04 Promote safer multi-occupancy mobility options

High occupancy rides provide a way out of congestion. However, in a post pandemic world, securing hygiene conditions and public acceptance will be a significant challenge. MaaS can help transport restart its journey.

NO REGRETS DECISIONS

- Implement communication systems providing real time information on public transit crowding levels
- Encourage flexibility in the number of days a week or month a MaaS subscription can be purchased, given the likely increase in working from home
- Promote a shift in public willingness to share information for MaaS providers to lead the transport industry into a safer yet socially responsible era
- Research applications of nudge theory and flexible pricing structures to change travel behaviours

PROMOTING A MORE DYNAMIC VIEW OF OUR TRANSPORT SYSTEM

MaaS has a real part to play in that it is creating seamless connectivity between personal and shared mobility, and active mobility as well. MaaS takes a holistic view on the transport ecosystem, enabling it to plan for the new ways different systems will interact

A fine balance needs to be struck between empowering users with reliable real time information while not overwhelming them with safety-based information that actually puts them off travelling entirely, especially using shared transport.

The principle of high occupancy rides still applies post COVID-19 - limiting the use of road space per passenger can be achieved in a number of ways.

IMPROVING EXPERIENCE THROUGH MACHINE LEARNING APPLICATIONS

Accurate predictions allow operators to target users in the right places at the right time with a vehicle that is adapted to real-time needs. The technology matching trips will improve continuously.

Case study

MACHINE LEARNING TO IMPROVE PUBLIC BIKE SHARE SCHEMES

Arup developed an interactive dashboard allowing the user to carry out detailed predictive analysis on a station-by-station basis. Using the dashboard it is possible to establish usage patterns over times of the day, week and year; thereby increasing the overall cost-efficiency of running the service.

05 Introduce an open Mobility as a Service platform

Transport authorities must find ways to compel mobility providers to sign up to a service platform shaped towards achieving public objectives.

NO REGRETS DECISIONS

- Establish early terms of reference between city and mobility partners
- Match regulation to the level of understanding, risk and maturity of particular issues
- Consider flexible solutions with piloting, and competitively sourced franchise suppliers
- Consider long-term legislative developments that restricts unregulated entry but allows for future changes once understanding is established
- Review the potential financial benefits for platform providers

INTEGRATING THE TRANSPORT SYSTEM

An integrated mobility offer that caters for all users is reliant on public and private stakeholders coming together. Policy should be put in place to ensure public goals are met.

GOVERNING PUBLIC-PRIVATE MAAS MODELS

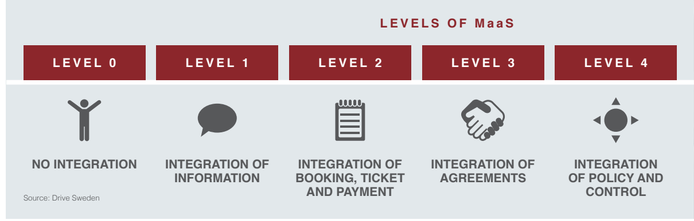
Future MaaS must be constructed with the right balance between public and private transport expenditure, between regulation and private ordering regimes, and between private transport service providers and public mass transit.

CREATING SEAMLESS CONNECTIVITY BETWEEEN PERSONAL & SHARED MODES

MaaS takes a holistic view on the transport ecosystem, enabling it to plan for the new ways different systems will interact.

AS ALWAYS, DATA IS KEY

MaaS providers already offer users ways to know occupancy rates of certain modes, with the ability to predict this not far away. A balance should be struck between empowering users with real time information while not overwhelming them with safety-based information. For MaaS to help lead the transport industry into a safer but socially responsible era, the right data will be key.



Source: Drive Sweden

Case study

MAAS GOVERNANCE AND ORCHESTRATION

Many trends and disruptions are beginning to highlight city-wide mobility challenges that need to be addressed. In this ever-present future of global mobility, government must be cognisant of their role to protect public value and interests, while ensuring they can efficiently support progress and innovation.

This research begins to investigate some of the critical considerations we should be making on behalf of our cities, as well as a number of MaaS specifics, identifying some of the areas we should be focussing on to uphold, maximise and optimise public value in the future.

06 Plan for accessibility before connectivity

Trading longer car trips for active travel, micromobility, local living and neighbourhood self-sufficiency can revitalise high-streets without negatively impacting on the success of business districts.

NO REGRETS DECISIONS

- Reduce the underlying need for travel by promoting sensible part-time work from home and part-time office-based working policies
- Consider making temporary active travel lanes, or 'corona lanes', permanent
- Consider closer integration of micromobility options with transit to support moving away from car-based travel
- Ensure adequate, segregated infrastructure is provided for active travel and micromobility

RETHINK HOW WE TRAVEL

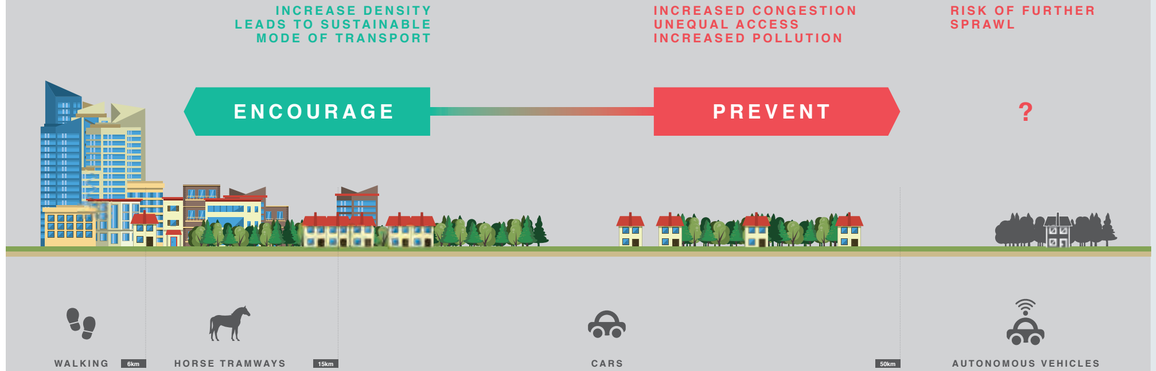
There is a once in a generation chance to reset people's ideas on how they make their day-to-day journeys. Road space throughout the world is being reallocated to active travel. Assuming that some of our new habits are mixed with our old ones post COVID-19, where does that leave us? Probably with only slightly fewer work trips overall, as so many of us cannot work from home. Finding the right balance between local living and commuting, and active versus non-active travel is the key to unlocking a more sustainable and safer urban transport system.

DENSITY IS NOT THE ENEMY

Dense, urban areas can provide more benefits in times of crisis, such as more services and amenities within walking distance or even without the need to leave home, concentrations of medical facilities and a workforce who can increase capacity for care, and decreased risk of isolation for seniors and vulnerable individuals.

CITY SPRAWL AND WIDELY ADOPTED TRANSPORTATION SYSTEMS

New technology has meant that walking eventually led to horsepower, and onto motoring, but that the time spent travelling has remained constant. This figure has impacted on many aspects of the built environment. Shared CAV technologies will increase the convenience of car travel, and with it might increase the risk of further urban sprawl, leading to more congestion, pollution and unequal access to jobs. Transport is a derivative of land use, not the goal. New transport technologies should be used as an instrument for better planning of local communities and land use.



Case study

CARDIFF CITY CENTRE REOPENING

Cardiff Council has appointed Arup to support Cardiff city centre plan for its reopening. The firm is developing a strategy that addresses both the immediate challenges around reopening the city centre and the longer-term opportunities to improve public space in the city as we move out of lockdown.

The strategy will initially focus on ways to bring people back into the city and support the reopening of businesses, taking social distancing into account. Looking beyond COVID-19, it will investigate opportunities to improve access to high-quality open space, digital networks, air quality, resilient infrastructure and active travel.

07 Introduce flexible spaces

Connecting vehicles can help to implement flexible street designs that allow for changing use over time.

NO REGRETS DECISIONS

- Design street policy frameworks that promote active travel modes and vibrant and attractive public realm
- Design street policy frameworks that promote a shift in vehicle travel demand, particularly for freight outside of peak hours
- Design new agent based modelling capability to understand the impact of road network changes on different users at different times of the day
- Consider the required changes with regards to regulation of roadway materials, traffic management, and signals

SAFETY CHALLENGES

Streets need to support a wide range of users and their competing demands by providing clear and consistent information that acknowledges where, when and how users should interact.

THE IMPORTANCE OF ANALOGUE

Removable bollards, reversible lanes, and visual indicators (e.g. smart flooring) are necessary for a safe transition between modes and differential uses of curb space.

CONNECTED VEHICLES WILL HELP MAKING FLEXIBLE STREETS A REALITY

Real time updates about changes in road layout helps with enforcement. The A2M2 corridor in the UK connects vehicles and infrastructure wirelessly, giving drivers advanced access to road closures or congestion warnings.

FLEXIBILITY DRIVEN BY NECESSITY

Many cities have been able to rapidly repurpose street and road layouts to provide safe room for pedestrians and cyclists to support social distancing requirements. Many of these temporary changes have been approved and deployed rapidly, demonstrating what can be achieved.

Case study

ARUP FLEXKERBS

Driven by local policy and real-time data. Arup FlexKerbs intelligently adjust the allocation of kerb space uses throughout the day and week to ensure that streets achieve local transport goals by accommodating or managing demand for all users.

08 Interoperability is key

Interoperability allows for better mobility management, new business models to flourish and the right governance to be put in place to promote safe and efficient transport flow.

NO REGRETS DECISIONS

- Understand stakeholder relationships and who sets the communication standards, then work to develop international standards in the automotive industry
- Consider a sandbox approach to collaboration - bring public and private enterprises together to drive collaboration to help identify and unlock business value
- Support network operators to work together to create the right environment, sharing and understanding the value of data

WORKING TOWARDS SEAMLESS MOBILITY

Different players, roles and layers of data streams shape the relationships within the connected mobility ecosystem. Interoperability is the key to an integrated connected mobility environment.

A MAGNITUDE OF BENEFITS

Driven by the ease of access and seamless communications, real-time information and decision windows are shortened, which leads to a more user-centric and efficient mobility system. An interoperable mobility environment enables a comprehensive management of city systems and mobility services.

Case study

UK AUTODRIVE AUTONOMOUS VEHICLE TRIALS

Working collaboratively for the first time, Jaguar, Land Rover, Ford and TATA Motors have developed common standards for a number of connected car features that allow vehicles to talk to one another and to road-side infrastructure such as traffic lights. Trialling such technologies in real-life city setting has helped to establish the technology readiness of the cities and for authorities to determine what needs to be done to prepare for connected autonomous mobility.

UKAutodrive

JAGUAR

LAND ROVER

Ford

TATA MOTORS

09 Safety and trust is a must

A hacked connected vehicle or infrastructure is a security risk that puts people's lives at risk. In-vehicle services should be designed with non-intrusive and privacy principles at their core.

NO REGRETS DECISIONS

- Encourage friendly hackers to uncover security vulnerabilities around connected infrastructure to help secure networks
- Develop risk assessment tools to quickly address threats as they arise in the vulnerability chain of infrastructure, vehicle and back office
- Develop cyber vulnerability assessment at the design stage of new infrastructure projects
- Develop open data sharing platforms to help companies enhance and accelerate development of connected vehicles capabilities, in which strong data privacy standards can be enforced
- Implement cybersecurity risk dashboards

INCREASED SAFETY IN OUR CARS, IMPROVED NETWORK EFFICIENCY

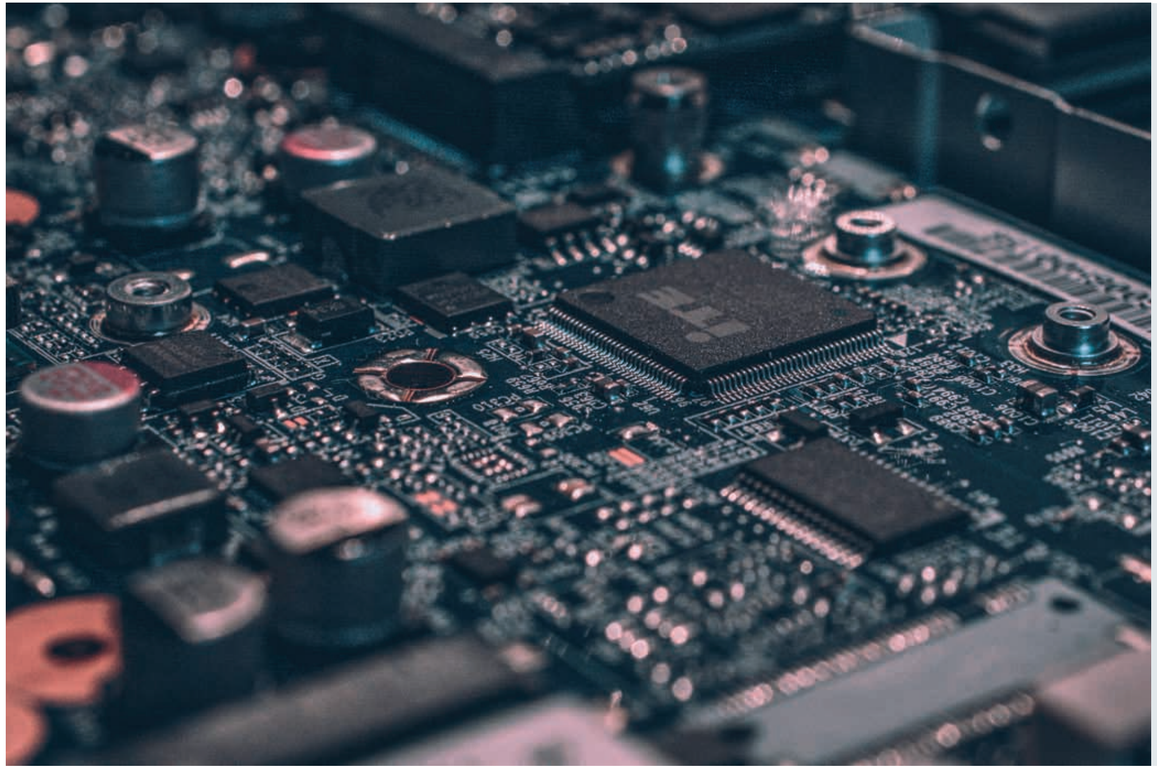
As cars become more connected, new applications such as prioritising emergency vehicles access, collision and road works warnings, and in-vehicle signage will further increase safety, and network efficiency (road space, parking and traffic optimisation).

BUILDING TRUST, DATA INTEGRITY AND PUBLIC ACCEPTABILITY

Whether mobility data is used internally (within operations of the vehicle) or externally (to manage congestion, parking, smart routing, or for commercial purposes) it will need to be managed with privacy and public value as a core principle.

TREAT DIGITAL ASSETS THE SAME AS PHYSICAL ASSETS

As with physical assets, the threats, opportunities and risks of digital assets must be fully understood and monitored against ongoing operations to protect both the asset and users.



Case study

CYBER ASSESSMENT FRAMEWORK FOR NETWORK OPERATIONS

Arup has addressed the risks, likely impacts, and mitigation relating to cyberattacks on all elements of connected infrastructure systems, and translated this examination into a powerful tool for the management of connected vehicles on a road network. Risks are captured and assessed, so that the live situation on the roads can be accessed by the relevant control staff. Using this information, these actors can understand the triggers and map the respective cyber risks, using a dashboard tool to access a list of mitigation and control measures for live situations.

BRINGING ALL THREE CONCEPTS TOGETHER

10 Re-think how land is used

The widespread adoption of connected, shared, and autonomous vehicles will have lasting impact on the form and function of our cities.

NO REGRETS DECISIONS

- Explore funding models that can viably enable investments required to transform spaces (i.e. through tax increment financing or business improvement districts for example)
- Investigate impacts on land values (think timing) and include re-zoning of parking space into local plans
- Investigate models and potential locations for servicing centres and fleet storage
- Investigate new municipal revenue sources (consider replacing parking revenues to kerbside use tax)
- Encourage conversion and development of released land with a vacant land tax
- Investigate publicly held land bank models

THE RELEASE OF LAND

A high uptake of shared mobility will be correlated to a significant decrease in demand for on-street parking. Parking spaces may be re-assigned to increase density and improve the public realm and environmental performance of existing buildings.

ADAPTIVE RE-USE OF RELEASED LAND

Re-zoning parking land can create opportunities for higher land values through infill developments across residential and commercial uses. Land values can decrease if the release of developable land is not controlled. Parking spaces can be turned into parklets, micro-housing units or offices (e.g. Box park).

CHANGING HOW WE THINK ABOUT LAND USE

Land use in our cities has also been a point of focus as we adapt spaces to accommodate more active travel in response to COVID-19. It's likely that some cities will be changed forever, setting the precedence for change.

Case study

CAPITAL SURFACE TRANSPORT MASTERPLAN, ABU DHABI

Arup successfully managed the complex plan that was approved by all key Government stakeholders and the Emirate's Executive Council. The project, which involved significant multi-stakeholder engagement and included three major workshops, is based on '5 Goals' which drive the plan around quality of life; use of technology; a better economy and environment; and improved governance. These will be achieved with a new set of strategic policies which will underpin all transport investment decisions.

ARUP

The 10 thoughts for shared, connected and autonomous mobility are part of a wider set of ideas from Arup on the future of mobility. Other documents include:

- 10 thoughts for the future of low-emission mobility.
- 10 thoughts for next generation mobility pricing.

If you'd like to speak to us about any of our thoughts, contact: smartmobility@arup.com

Or visit www.arup.com